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Velocity-Space Distribution Functions of Protons and Alpha Particles in the High-Speed Solar Wind

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Velocity-space distributions of protons and alpha-particles in the high-speed solar wind are calculated from Ulysses SWOOPS data. Although a wide variety of one- and two-stream distributions are observed, there are systematic differences in the distributions which depend on the drift speed between the protons and alphas. An unusual alpha-particle distribution is found with remarkable consistency when the proton fluctuations are Alfvénic and the alphas surf on those fluctuations. Under those conditions the proton distribution shows two streams, with the faster beam being less dense than the slower beam. The alpha distribution is quite symmetric in the dimension parallel to the magnetic field and appears squashed in the perpendicular dimension. The alpha-particle isocontours look like cylinders with spherical end pieces. When the alpha-proton drift speed exceeds the value required to surf, the fluctuations in the alpha and proton velocities are out of phase with each other. Under such circumstances, the alpha-particle distribution function is no longer symmetric, but exhibits two beams, with the faster beam being the denser. For protons, the slower of the two beams continues to be denser than the faster beam. Possible microphysical processes that might be responsible for these distributions are discussed.

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